Spatial verification of COSMO forecasts for ICE-POP2018 (PyeongChang 2018 Olympics)

***A. Bundel*, M. Shatunova, D. Blinov, and G. Rivin**

Hydrometcentre of Russia

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Contact: a.bundel@gmail.com

ICE-POP2018: International Collaborative Experiments for PyeongChang 2018 Olympic & Paralympic winter games

- ICE-POP2018 is the WMO FDP/RDP project, which inherits the tradition of meteosupport projects for winter Olympic / Paralympic Games such as SNOW-V10 (Vancouver, 2010) and FROST (Kiktev et al, 2017)
- The main goal is **advancing seamless prediction from nowcasting to short-range forecast for winter weather over complex terrain** based on an intensive observation campaign

Motivation

- Availability of **high-resolution gridded data**: models and radar composites
- Need to assess the added value of very-high-res (550 m grid mesh) model version

Verification setup

- **COSMO-ICE2.2 and COSMO-ICE0.55** model versions,
  the standard one and experimental one with a new aerosols-cloud-radiation scheme
- 1h precipitation accumulations
- **Korean radar composites as reference data**
- Free R SpatialVx package (author E.Gilleland, NCAR) is used to run **neighborhood and object-based methods**

Test cases provided by the Korean colleagues

Mean rain rate (mm/1h) over cluster during Snow events

	Events	coast	OlympicPark	YPO	JSC	BKR
1	25.11.17	0.9	1.5	1.1	1.6	**1.8**
2	24.12.17	1.1	0.8	0.5	**1.7**	0.9
3	22.01.18	0.5	0.5	0.6	**0.8**	0.6
4	28.02.18	**2.0**	1.2	0.8	1.0	1.0
5	4-5.03.18	**2.6**	1.5	1.8	1.8	1.6
6	7-8.03.18	0.7	0.6	0.5	**1.1**	0.8
7	15-16.03.18	0.7	0.6	0.8	0.5	**1.7**
8	21.03.18	0.6	0.5	0.6	0.5	0.1

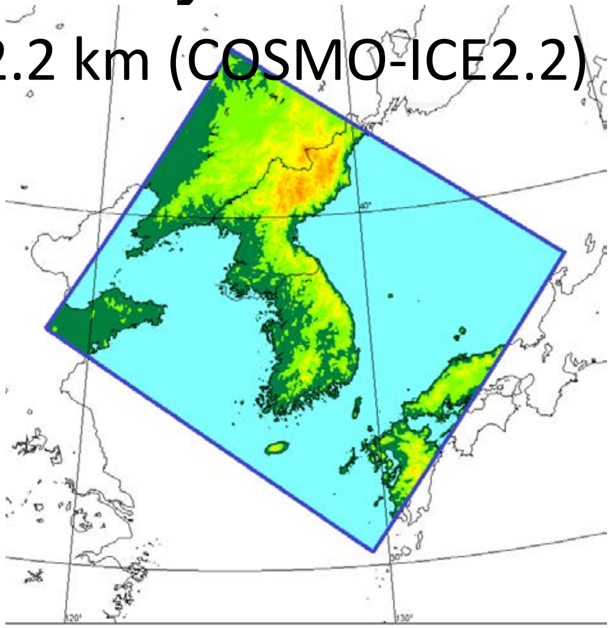
Maximum 1h precipitation sum over cluster during Snow events

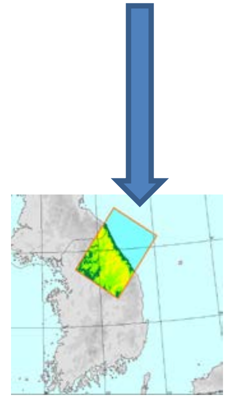
	Events	coast	OlympicPark	YPO	JSC	BKR
1	25.11.17	2.5	6.9	6.5	**8.3**	6.5
2	24.12.17	3.0	2.5	3.0	**14.4**	3.0
3	22.01.18	1.0	1.3	1.0	**3.7**	1.7
4	28.02.18	**8.5**	5.9	2.5	4.2	7.0
5	4-5.03.18	6.5	5.6	**9.3**	5.5	5.6
6	7-8.03.18	2.5	1.7	1.5	**9.9**	2.5
7	15-16.03.18	2.0	2.6	2.0	3.0	**8.5**
8	21.03.18	**1.5**	1.1	1.0	1.2	0.1

Model domains

- **Last year: smaller domain of verification**

2.2 km (COSMO-ICE2.2)

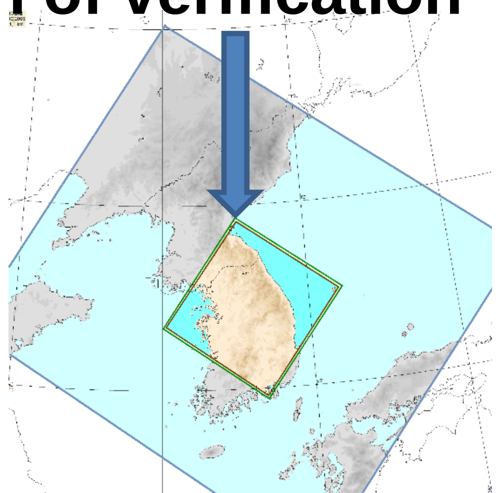




Last year we interpolated 2.2 km model and 1.1 radar fields to 0.55 km grid

0.55 km (COSMO-ICE0.55)

- **This year: larger domain of verification**



Simulated precipitation interpolation

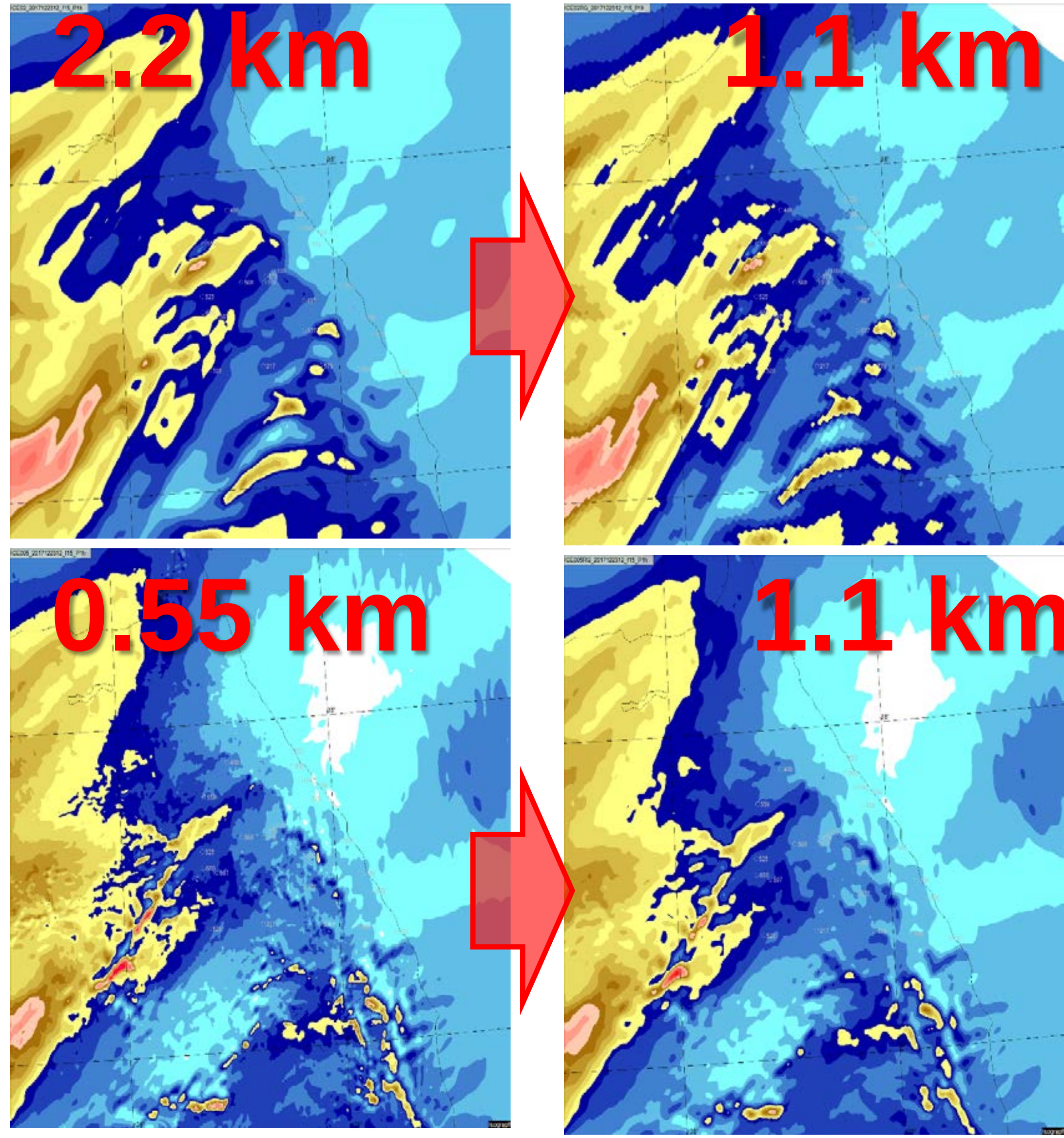
From COSMO-ICE02 grid to Radar data grid

2.2 km → 1.1 km

Interpolation method: ***"average"*** – arithmetic mean of values at neighbouring source points within 1.1km square

From COSMO-ICE005 grid to Radar data grid

0.55 km → 1.1 km

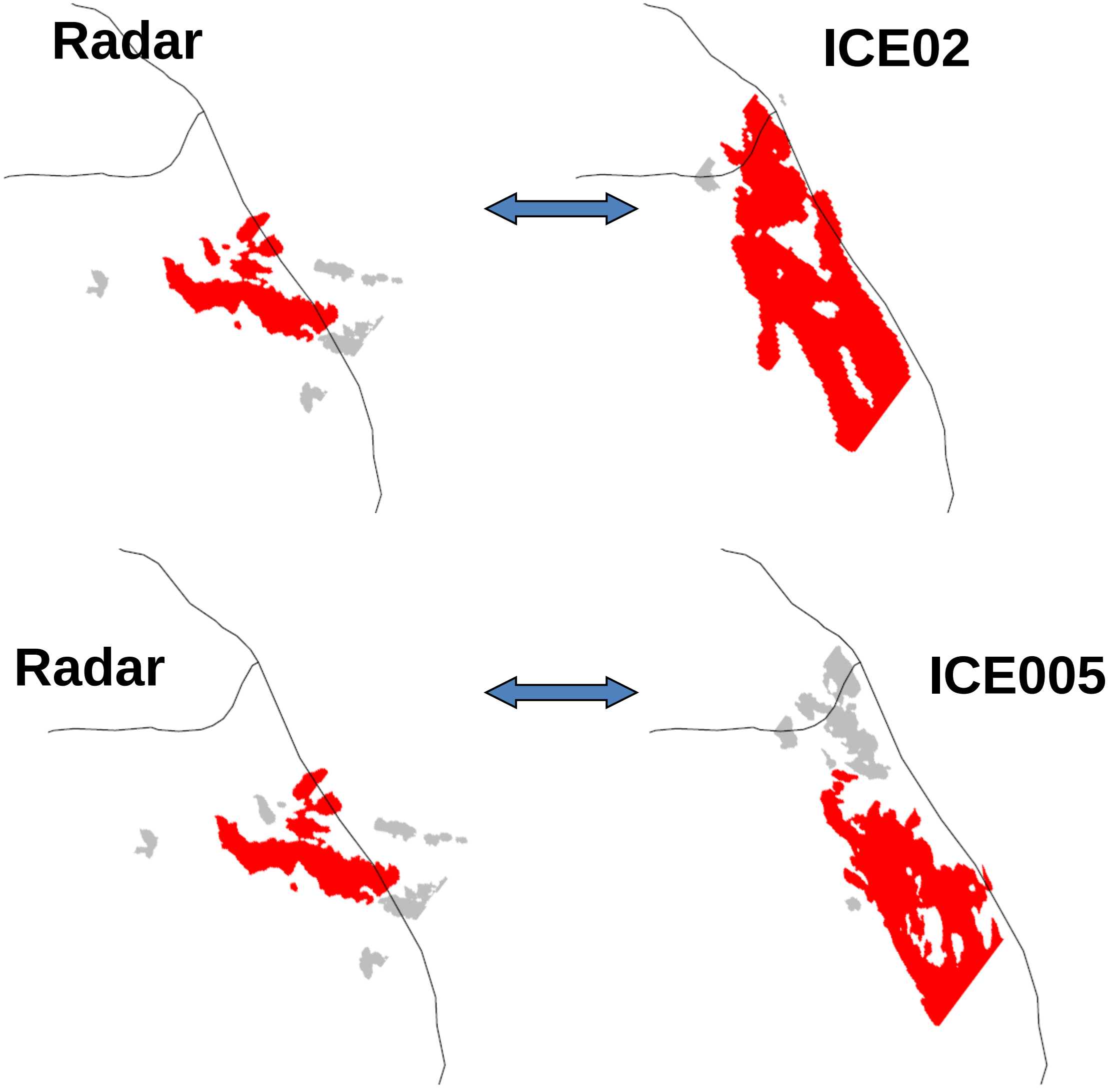


Experiments with object-based methods

Objects are contiguous areas with precipitation values greater than a certain threshold (hereinafter, 0.1mm/h)

Matching criterion: the objects are paired if the centroid distance between an object in the observed field and an object in the forecast field is less than the average size of two objects (the size is the square root of the object area)

2017 Jan 20 08UTC, lead time 08h, matched objects



Neighborhood methods

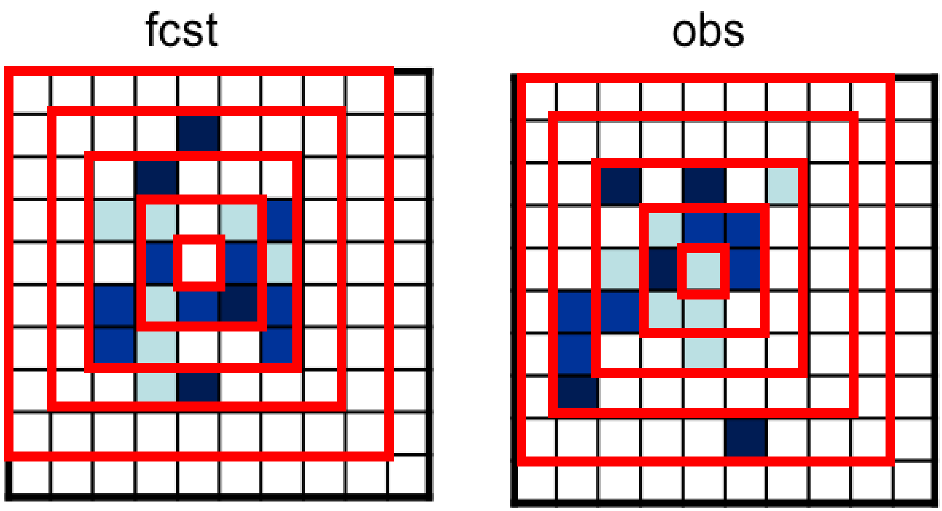
Relax the requirement for an exact match by evaluating forecasts in the local neighborhood of the point of interest

Fractions Skill Score, FSS (Roberts and Lean, 2008)**:**

Ideal forecast FSS = 1;   worst forecast FSS = 0.

P: fraction of grid cells with an event in the neighborhood

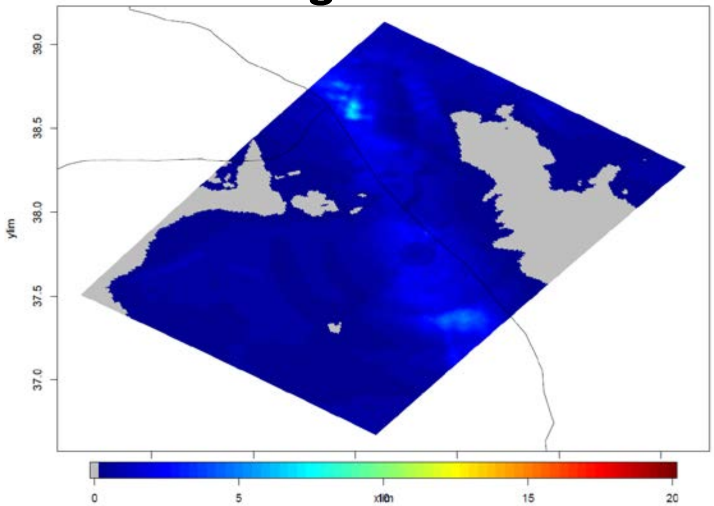
$$FSS = 1 - \frac{\frac{1}{N}\sum_{N}(P_f - P_o)^2}{\frac{1}{N}\left[\sum_{N} P_f^2 + \sum_{N} P_o^2\right]}$$

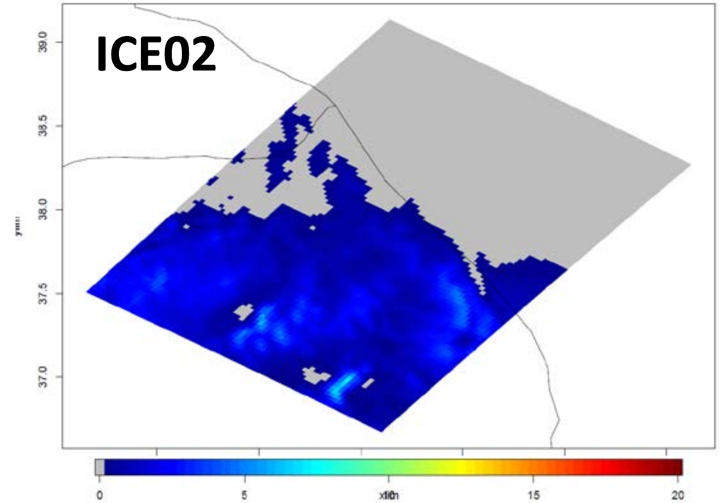


Worst forecast in denominator: there are no events forecast and some occur, or some occur and none are forecast.

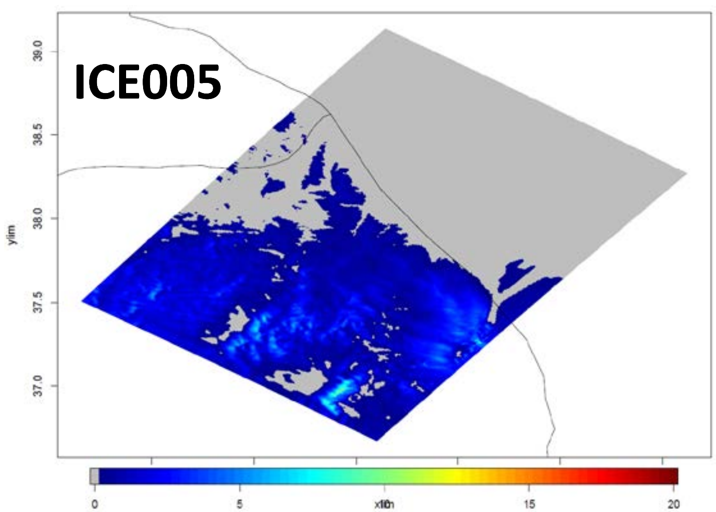
Smaller domain: 2018 Feb 28 06UTC, 6h lead time

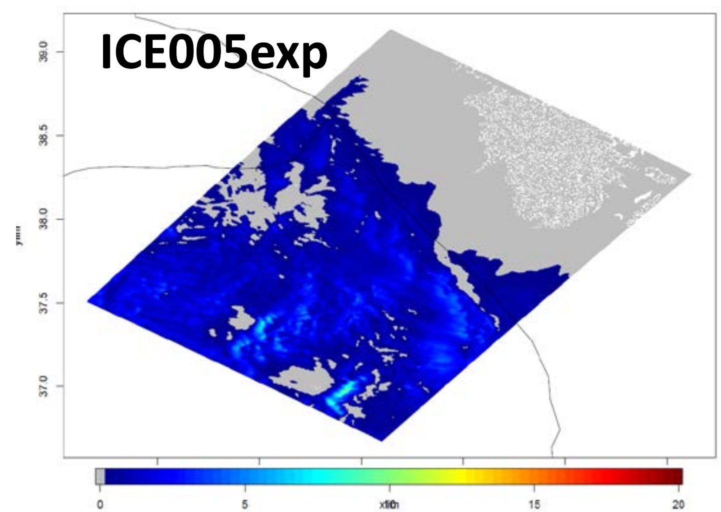
Radar data: Strange concentric circles



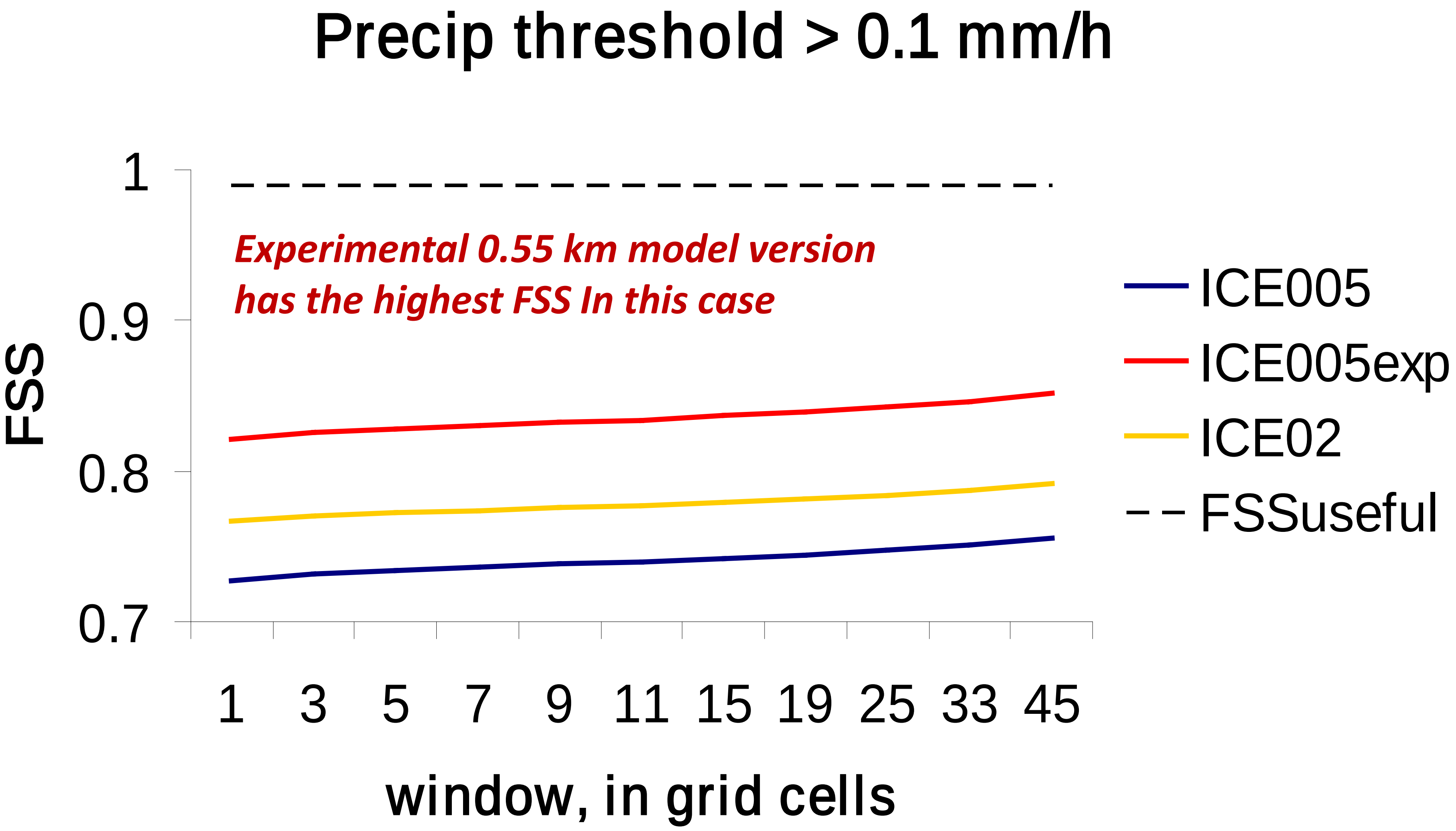


Most of the area is covered by precipitation, and the observed fraction is high even for high thresholds -> FSSuseful is close to 1.

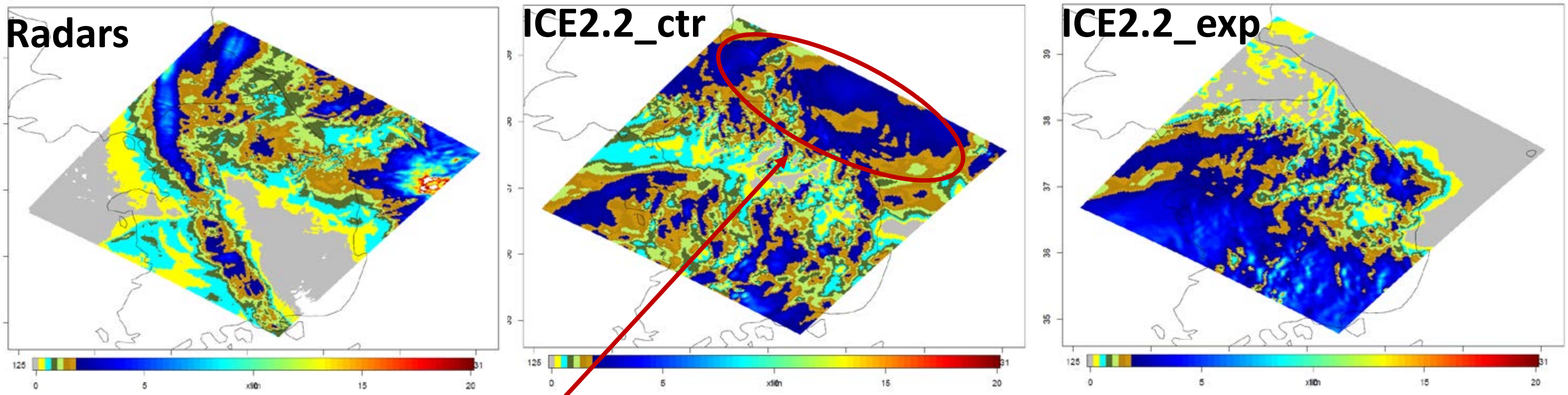


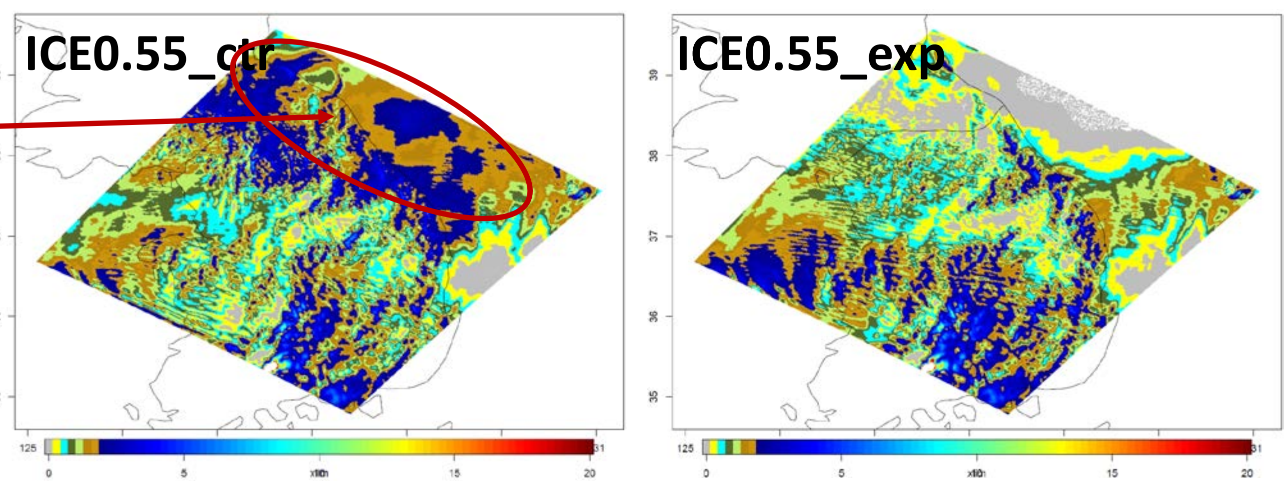


Smaller domain comparison
2018 Feb 28 06UTC, lead time 6h



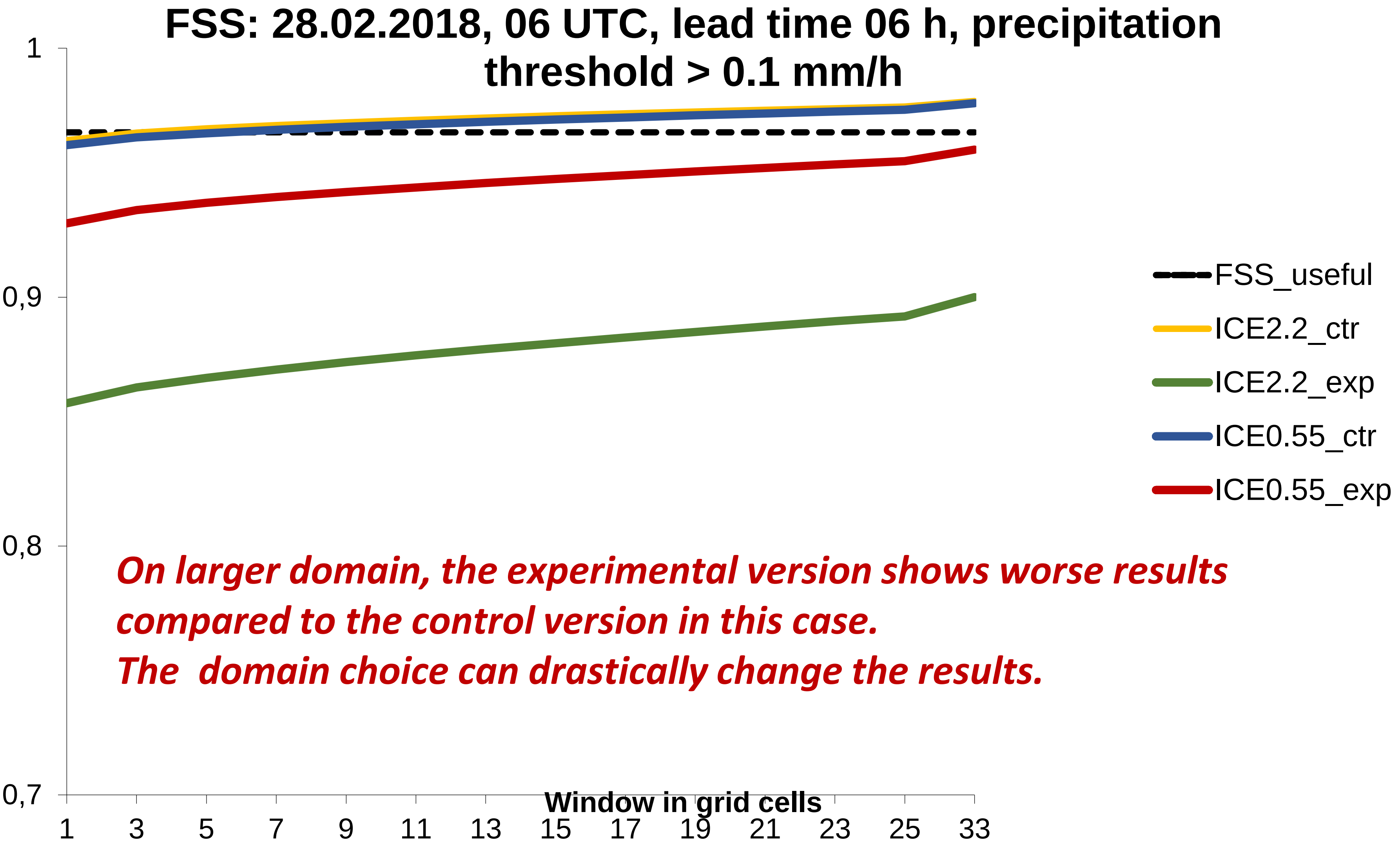
Larger domain precipitation fields, 28.02.2018, 06UTC, 06h lead time





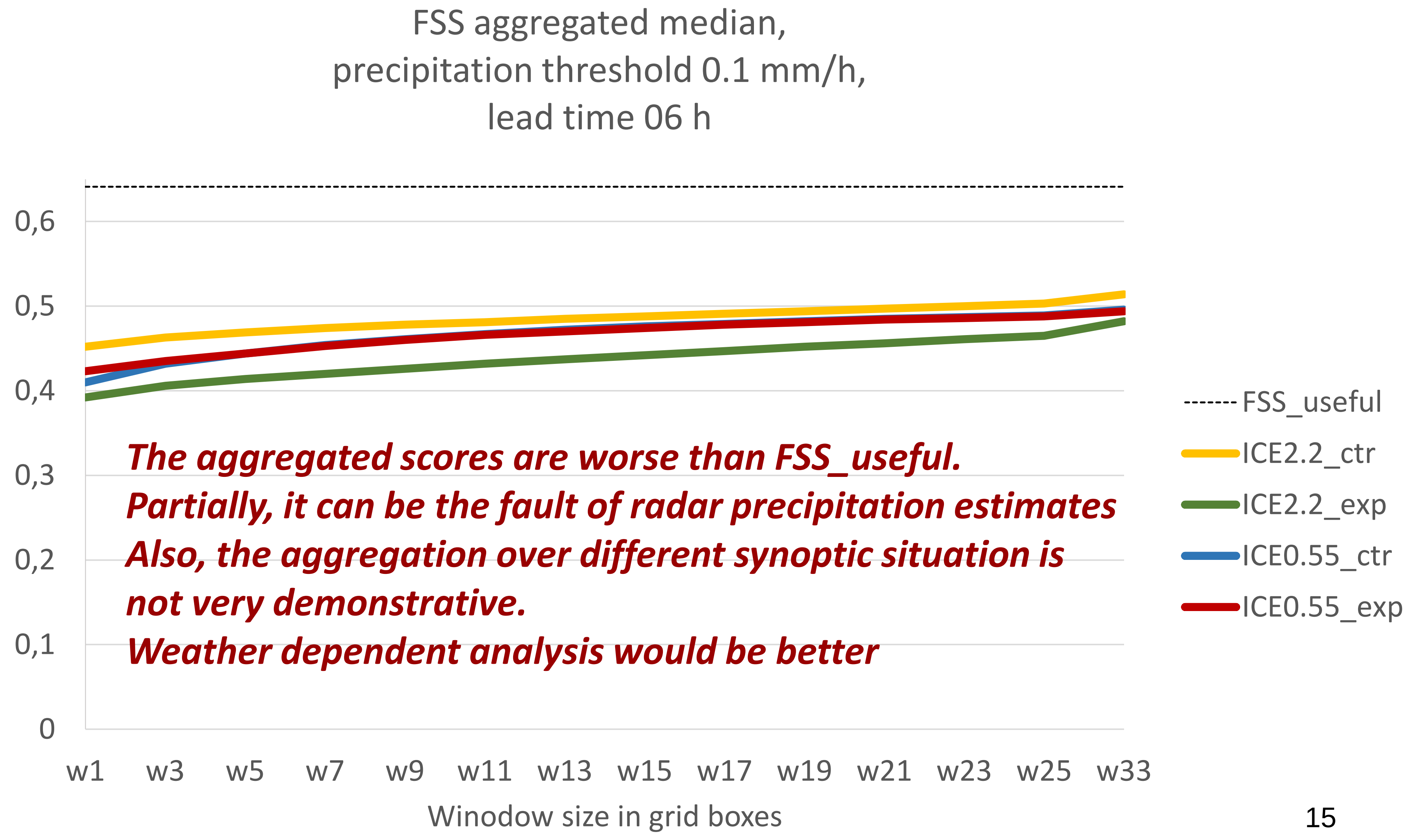
More precipitation in the off-shore Korean peninsula area in the control versions -> Better FSS scores

Larger domain comparison

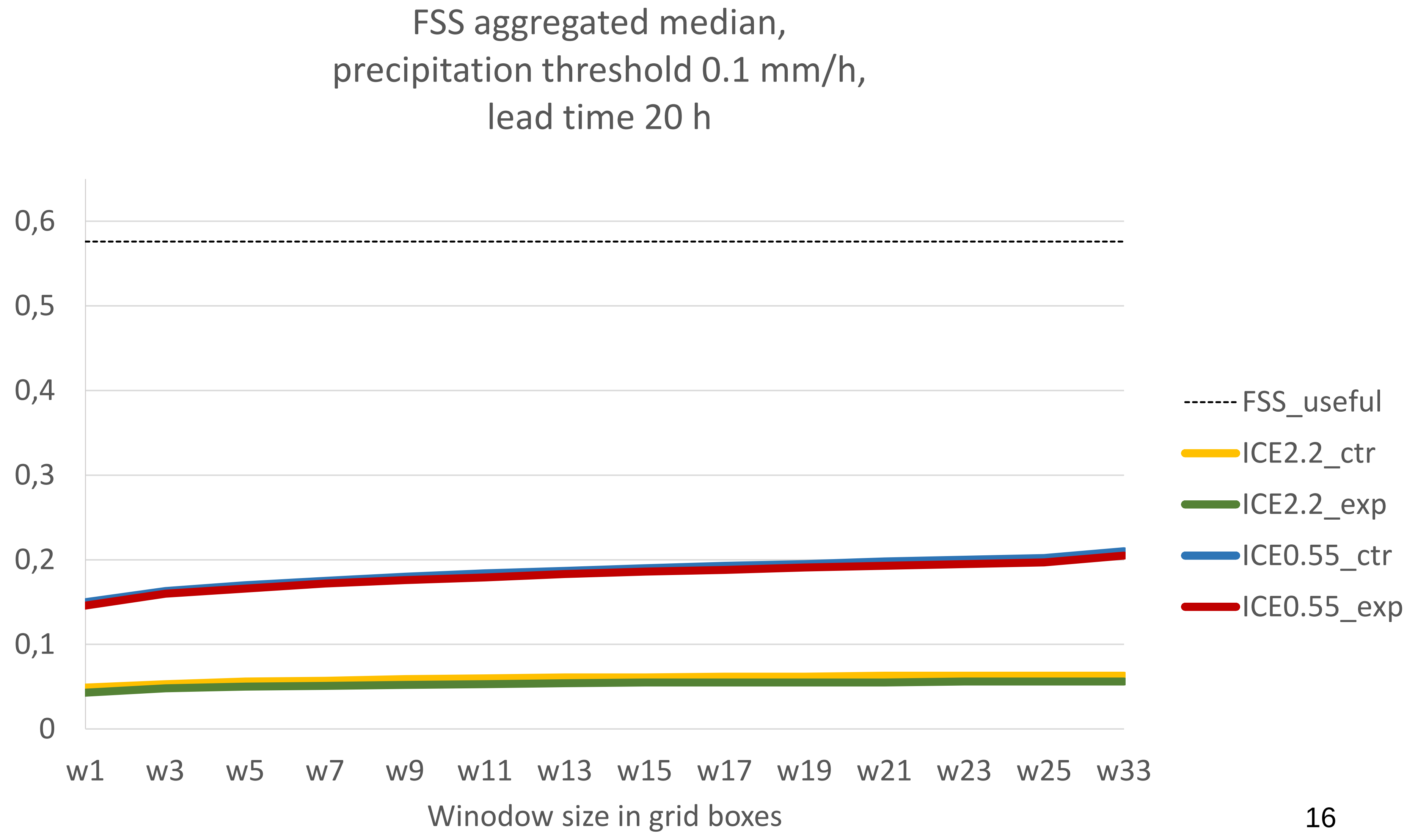


On larger domain, the experimental version shows worse results compared to the control version in this case.
The domain choice can drastically change the results.

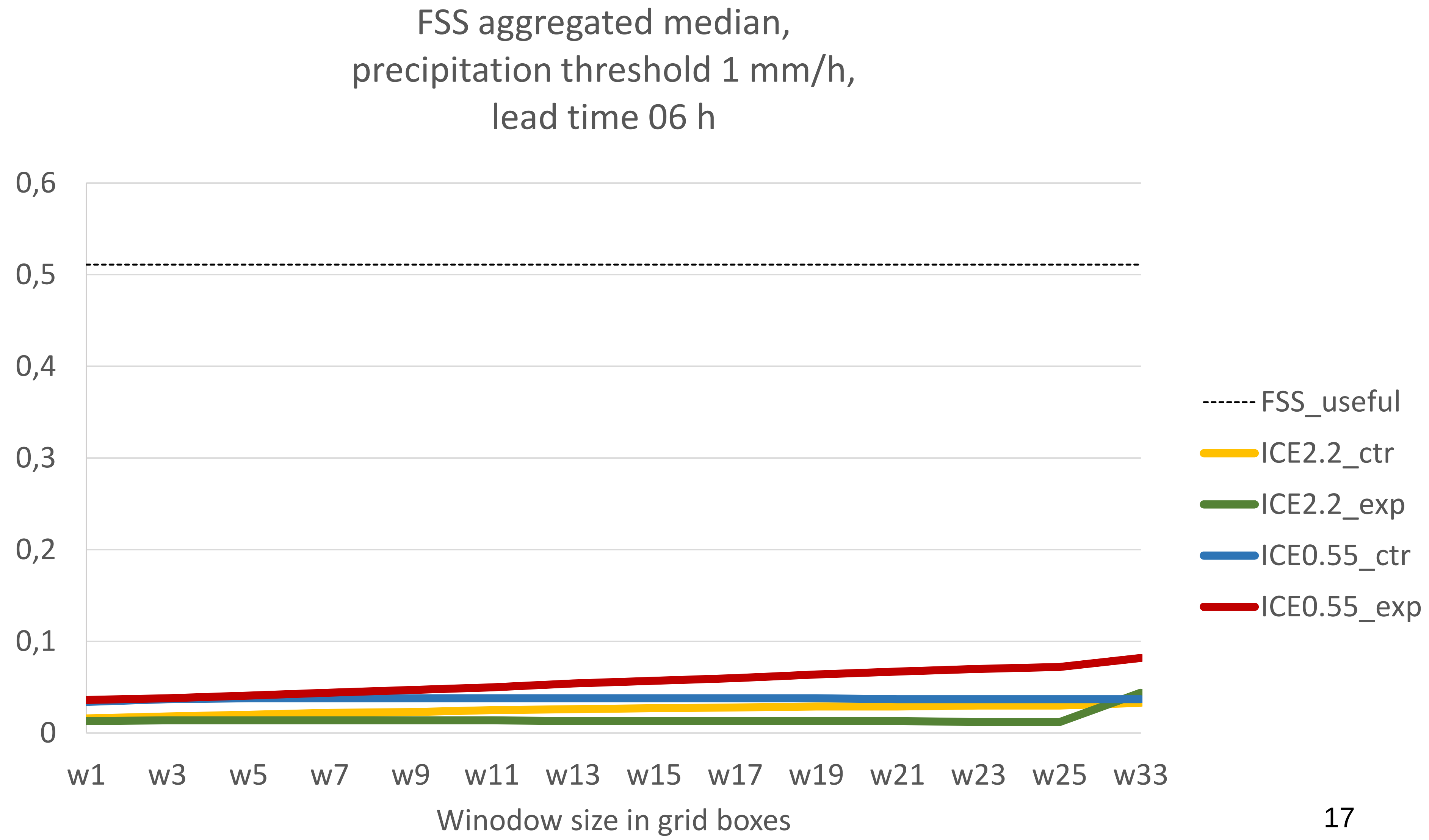
FSS aggregated over all test cases, lead time 06 h, threshold 0.1 mm/h



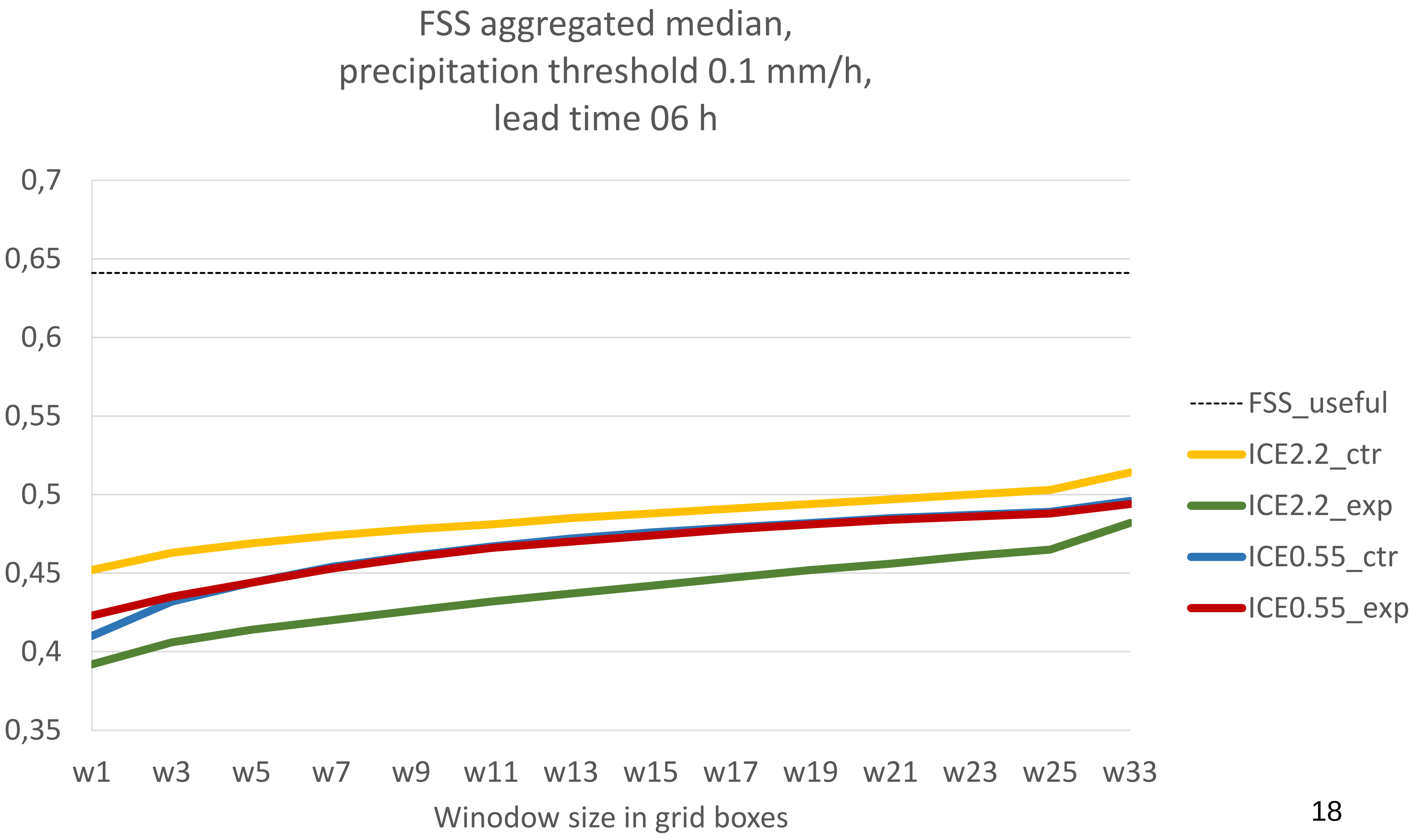
FSS aggregated over all test cases lead time 20 h, threshold 0.1 mm/h



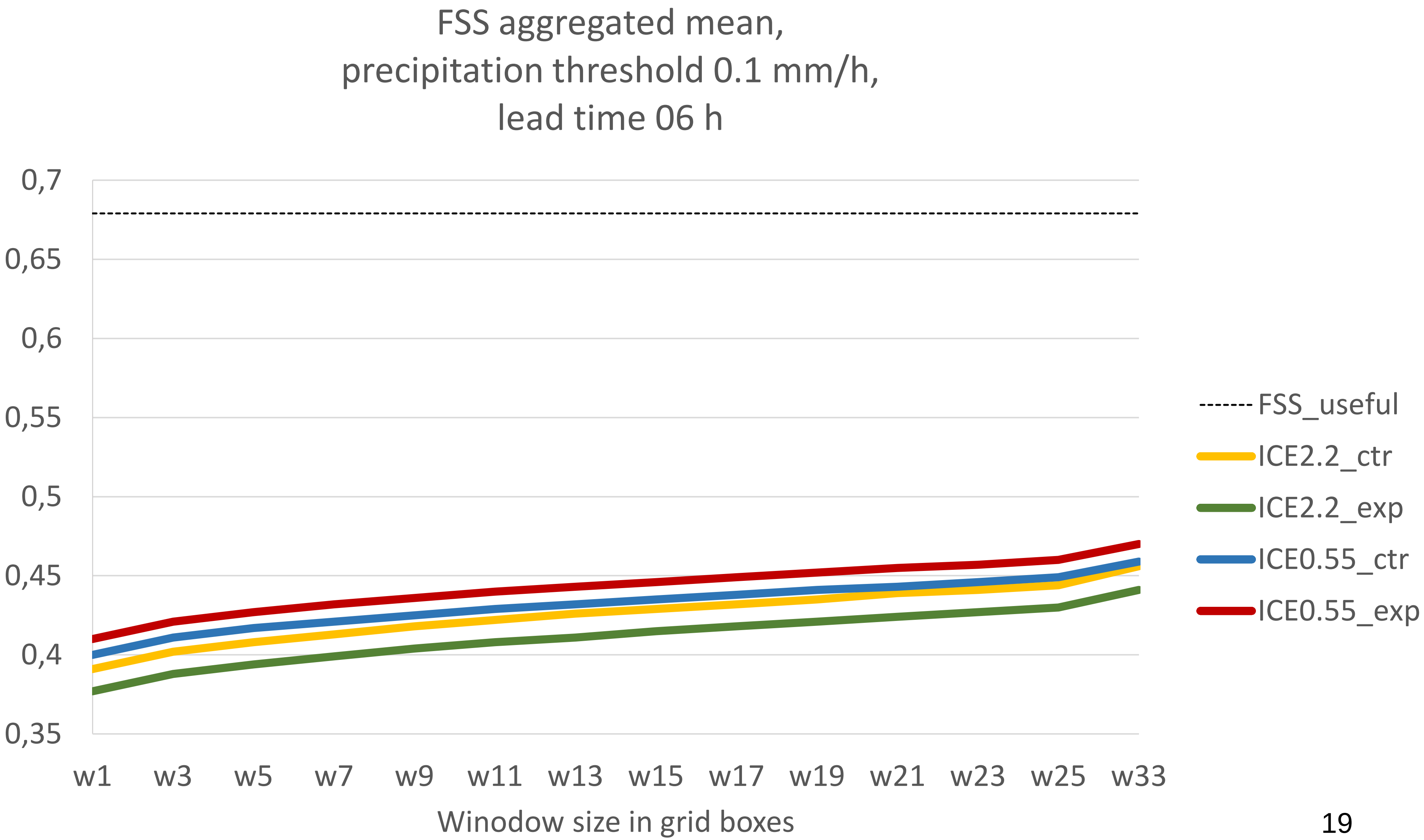
FSS aggregated over all test cases lead time 06 h, threshold 1 mm/h



Effect of choosing median or mean for FSS aggregation



Effect of choosing median or mean for FSS aggregation



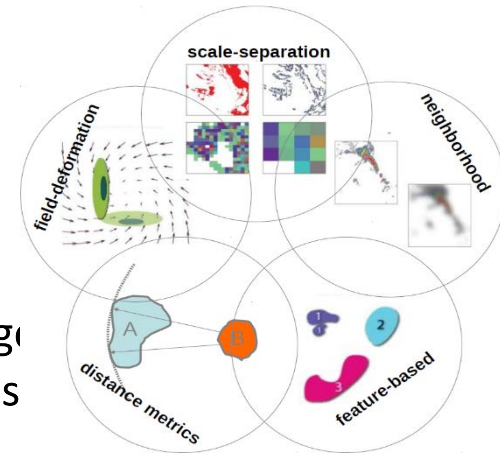
Discussion

- The feasibility of the application of spatial methods to COSMO-ICE total precipitation forecasts was tested on different test cases of 2017-2018. The FSS and object-based approach give reasonable results compared to human assessment
- **The domain choice can significantly change FSS verification results.** The advantage of higher resolution COSMO-ICE version with experimental aerosols-cloud radiation scheme was detected when verified on the smaller domain. On larger domain, the results are contradictory for different cases, the experimental version being even worse when aggregated over all precipitation cases
- Weather dependent verification is required instead of pulling all cases, but the problem of few cases appears
- The choice of FSS median or mean for aggregation can also provide different results

Plans

- Radar precipitation derivatives can overestimate real precipitation (Marina’s talk) -> We plan to verify reflectivity fields
- To continue with object-based approach
- To try other displacement metrics (next slide) and to compare them with the CRA displacement score

Displacement metrics



- Centroid distance (CDST)
- Mean Error Distance (MED)
- Baddeley's Delta (BDEL)
- Zhu's metrV (ZHU)

Used in digital image analysis and are based on distance maps.

- Displacement Fractions Skill Score (dFSS)
- Displacement Precipitation Neighborhood Score (dPNS) (G.Skok and N.Roberts, RMetS, 2017)

Subverted neighborhood methods

A novel set of geometric verification test fields and its application on distance measures
Eric Gilleland, Gregor Skok,
Barbara G. Brown, Barbara Casati, Manfred Dorninger,
Elizabeth E. Ebert, Marion Mittermaier, Nigel Roberts,
and Laurence Wilson